BARBULE STRUCTURE OF BIRD FEATHERS[1]

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(*With five plates*)

Key words: barbule morphology, bird-hits, bird taxonomy, feather microstructure, feathers

The structure of barbules from bird feathers has been studied by optical (bright field and polarized) and scanning electron microscopy (SEM). The factors which help in its identification are discussed and attention is drawn to similarities within related species and difficulties encountered.

INTRODUCTION

Optical microscopy of feather remnants has been employed to identify the species involved in bird-hit cases of aircraft (Rosalind and Grubh *JBNHS* 1987, *84*: 429-431). The general principle is that the nodal pattern on barbules, the colour at the nodes and their shape are characteristic of a species. The present paper is an extension of the work. In the case of bird-hits to aircraft, it is possible to identify the bird from other body parts, if they are in good condition. However, identification of a species solely on the basis of feathers is difficult, and analysis of the feather structure in greater detail is necessary. In addition to optical microscopy, where objects are viewed in a bright field, I have used polarized light microscopy and Scanning Electron Microscopy (SEM) to identify a species. A detailed study of this nature can help to identify birds involved in bird-hits, and also in taxonomy and in the control of trade in endangered species.

MATERIALS AND METHODS

Samples were obtained fresh, usually feathers floating in the air, picked up as they hit the ground, from the bird under observation. Three samples (i.e. crow pheasant, house crow and Indian pitta) were of dead birds, but without any apparent putrefaction. Samples for light microscopy were prepared as follows: Barbule feathers were washed in 70% alcohol, then in absolute alcohol, rinsed in xylene and mounted on glass slides with DPX mountant under a coverslip. This resulted in poor contrast in white feathers, hence those samples were viewed in polarized light. For Scanning Electron Microscopy, samples bearing barbules were mounted on double sided sticking tape stuck on to aluminium stubs, given a thin coat of gold and viewed in a Cambridge Stereoscan S 150 or a JEOL 5600LV instrument at an accelerating voltage of 10 kV.

RESULTS AND DISCUSSION

The micrographs obtained are shown in Figs 1-18. (Abbrev.: SEM = scanning electron micrograph, OMB = optical micrograph in bright field and OMP = optical micrograph in polarized light. The micron mark lines indicate 50 micrometres in the optical micrographs). Feather barbules from 18 species were studied. The SEM studies show surface features very well. Projections on the barbules are clearly seen. Fig. 1a is that of the Indian peafowl *Pavo cristatus*. The barbules are thick and the nodal projections are characteristic. The optical micrograph (Fig. 1b) shows some variations, depending on the plane of focus. Since the depth of focus, compared to the SEM, is very small for the optical microscope and we did not stain or take sections, we got an average effect, due to the thickness of the barbules. We noticed pigmentation in some regions, which was absent in other barbules, but a change in the focus point resulted in some contrast in these regions also. To the same observer, this would not be a problem as he would become aware of the variations possible, but in

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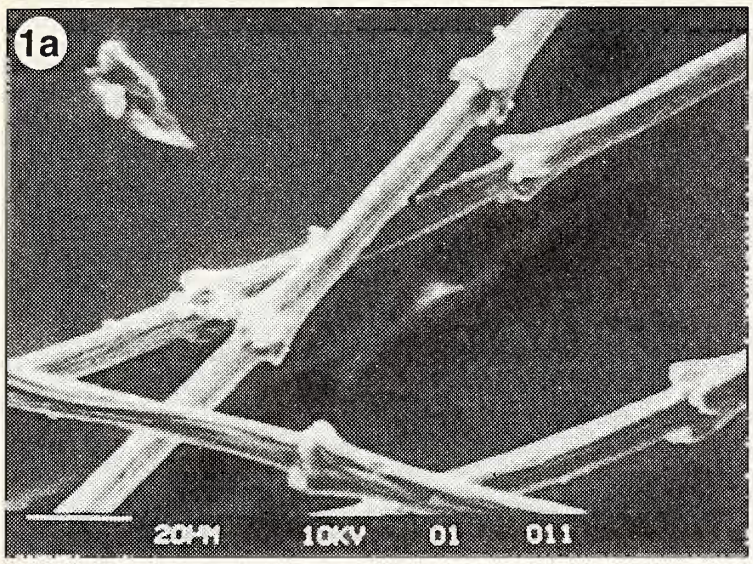
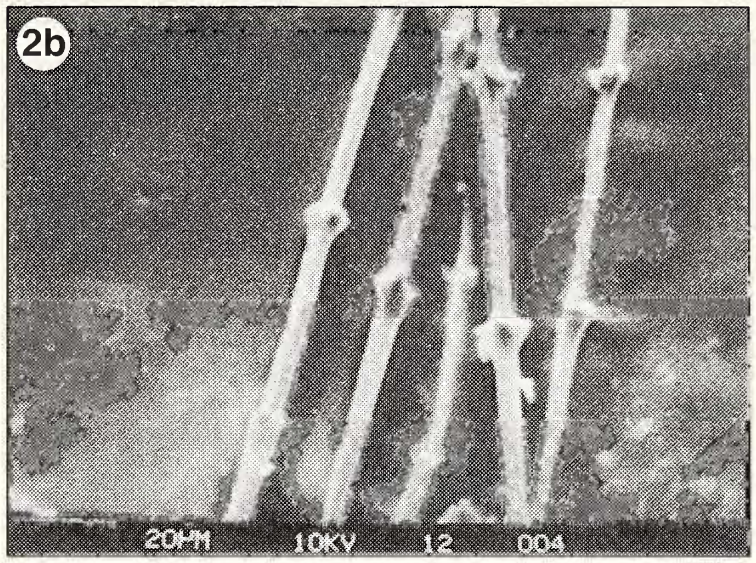
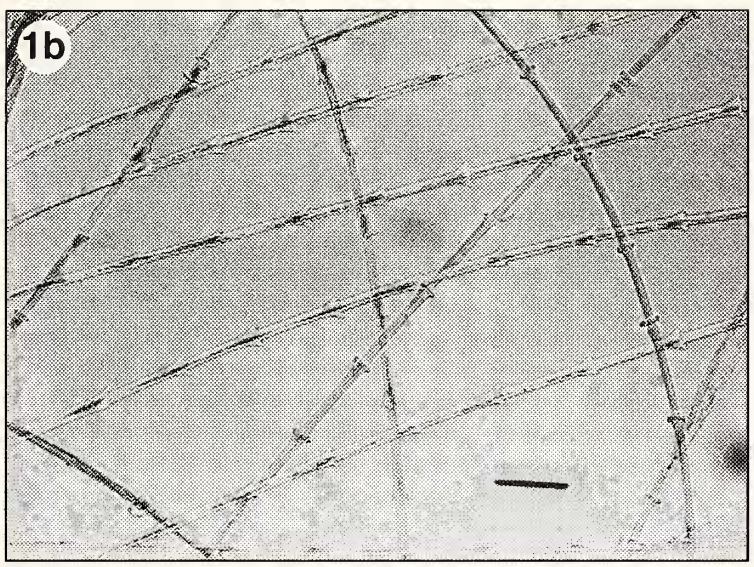
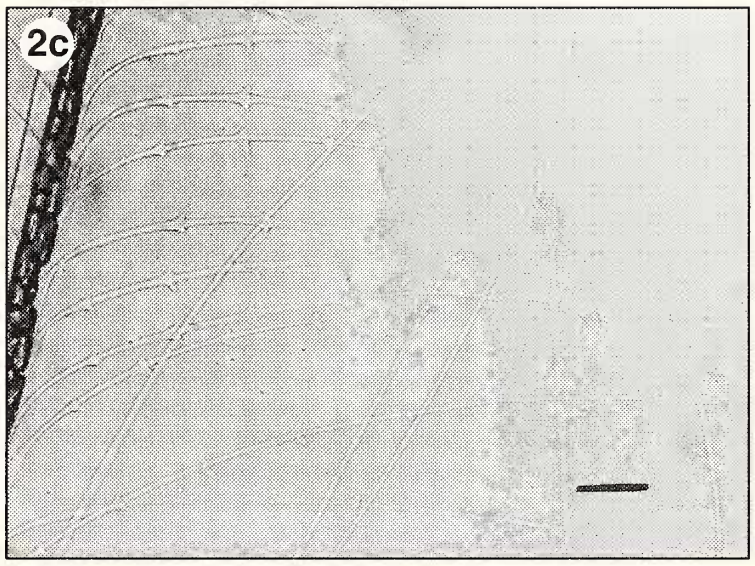
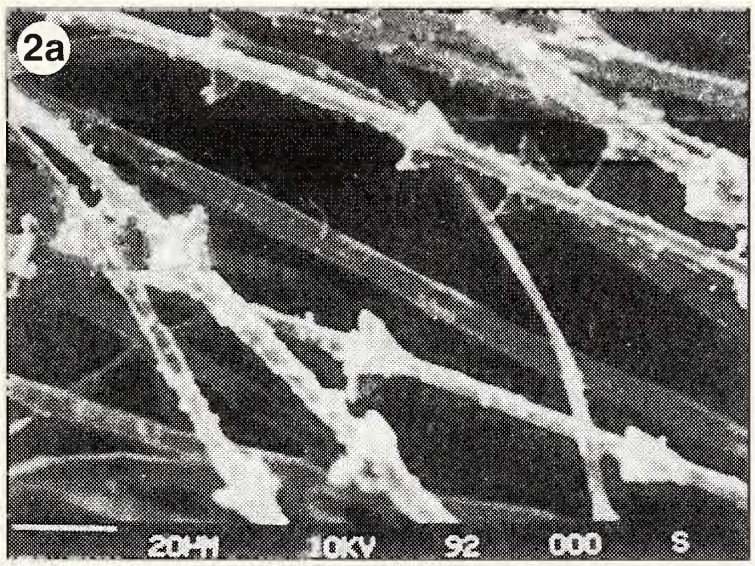
PLATE 1

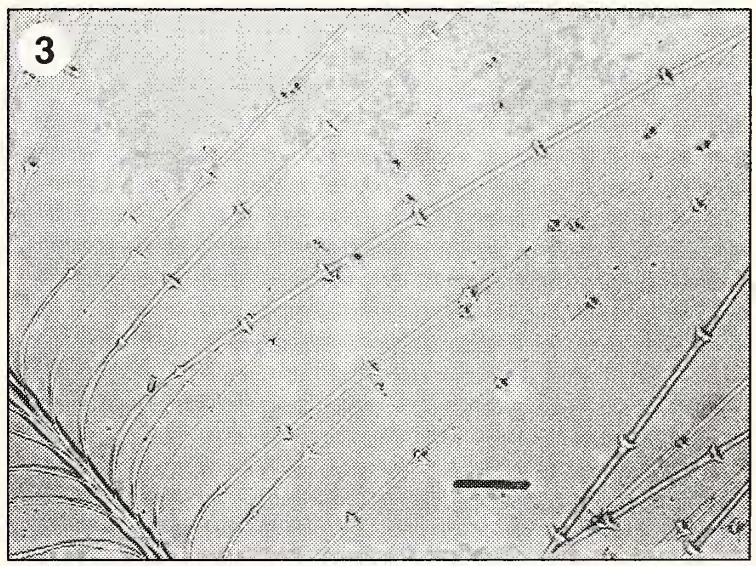












Figs 1-3: 1a. Indian peafowl (SEM), 1b. Indian peafowl (OMB), 2a. Blue rock pigeon (SEM), 2b. Blue rock pigeon (SEM), 2c. Blue rock pigeon (OMB), 3. Pompadour green-pigeon (OMB)

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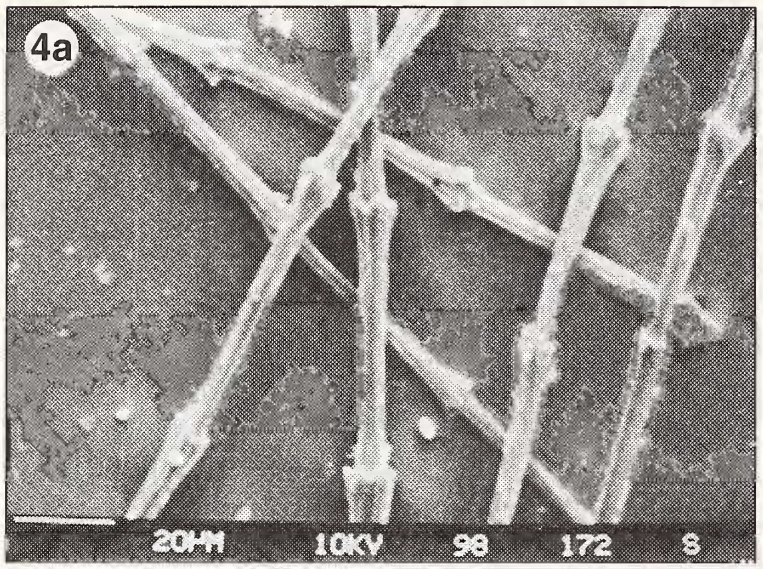
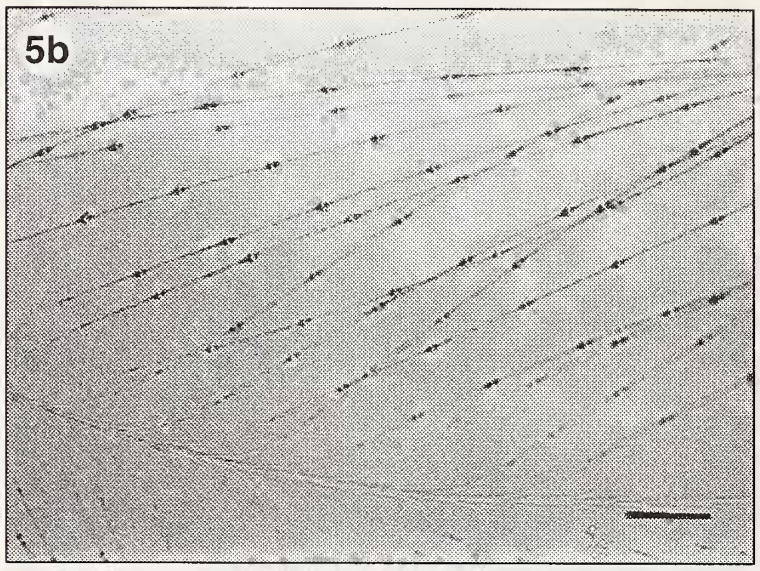
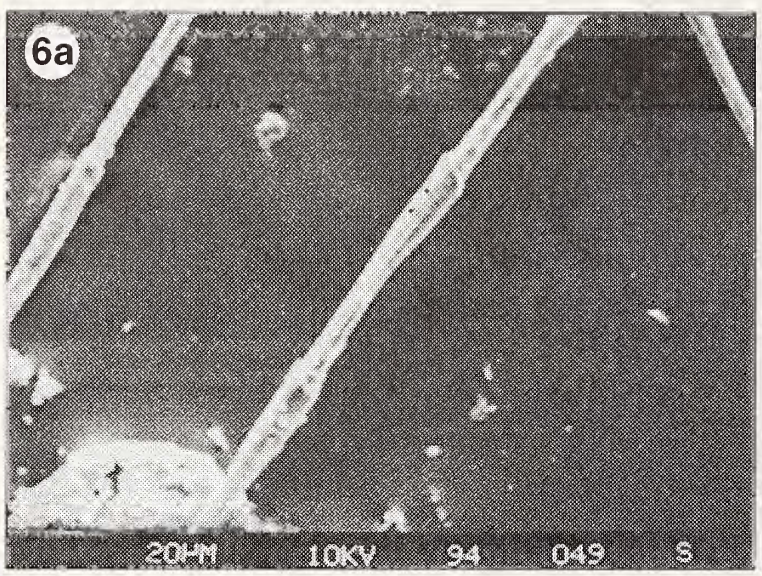
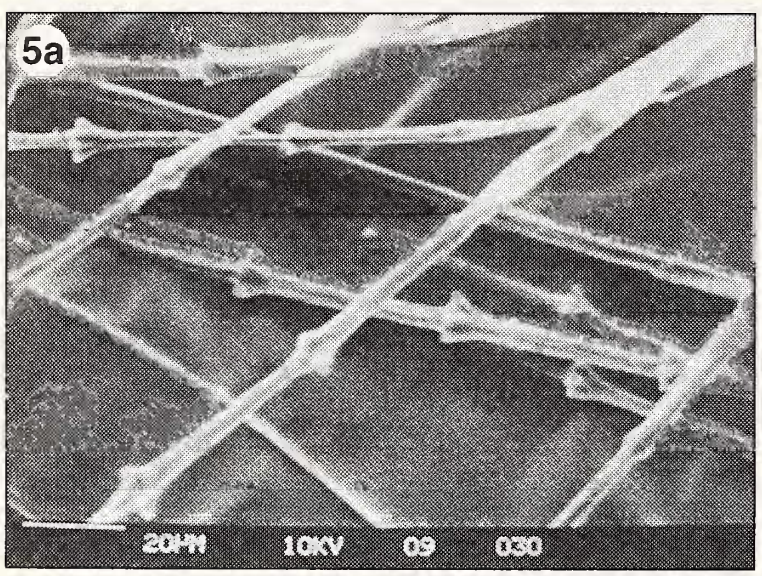
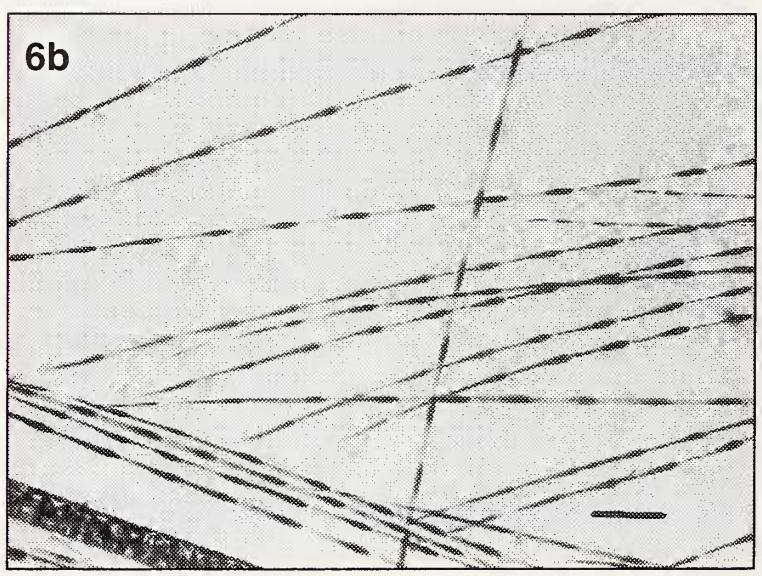
PLATE 2





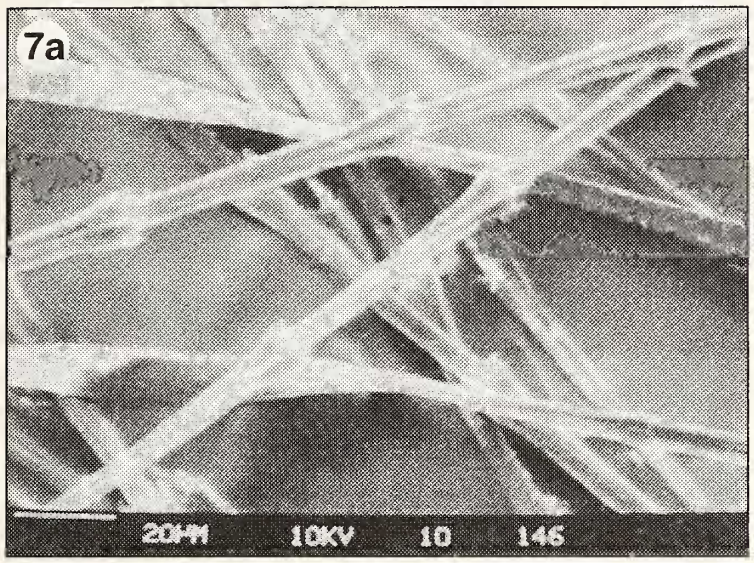


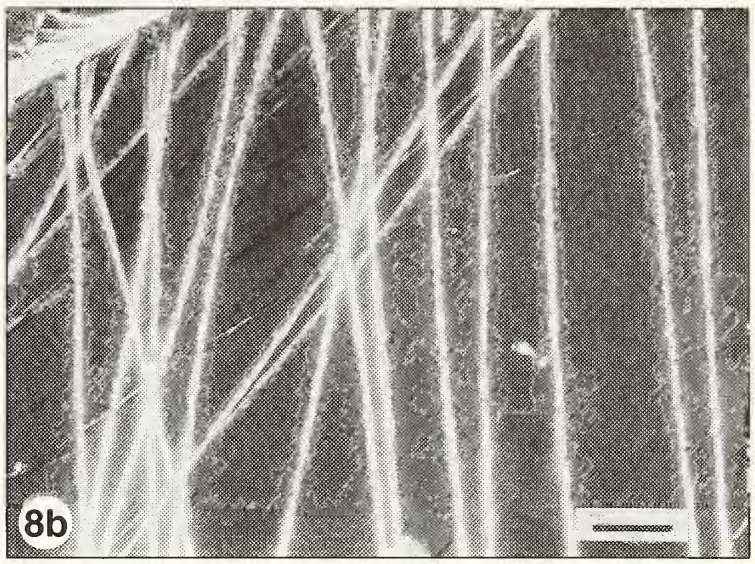


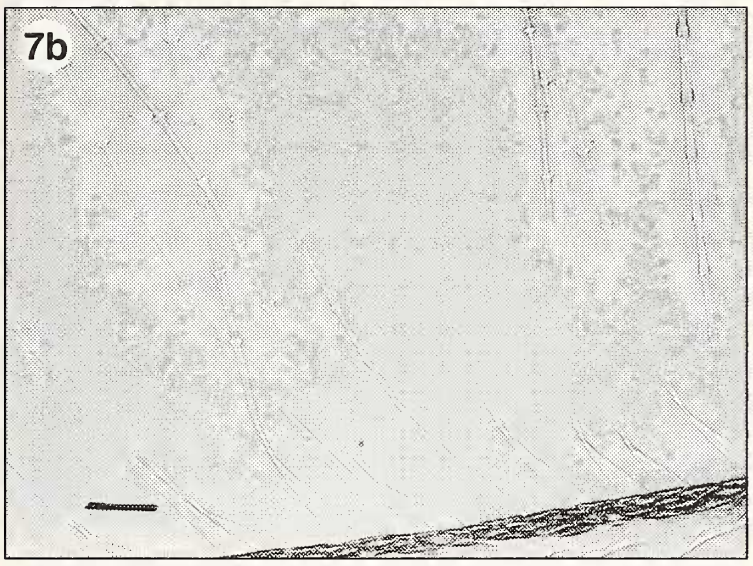


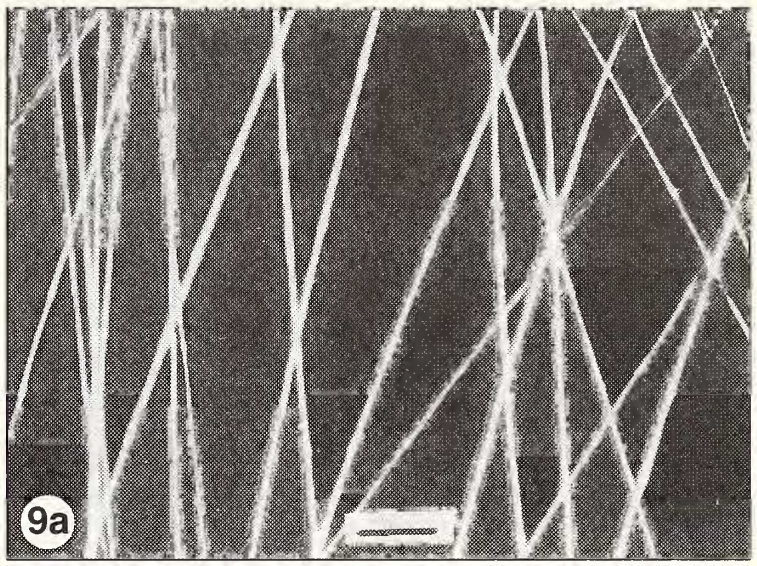
Figs 4-6: 4a. House crow (SEM), 4b. House crow (OMB), 5a. Common myna (SEM), 5b. Common myna (OMB), 6a. Indian pitta (SEM), 6b. Indian pitta (OMB)

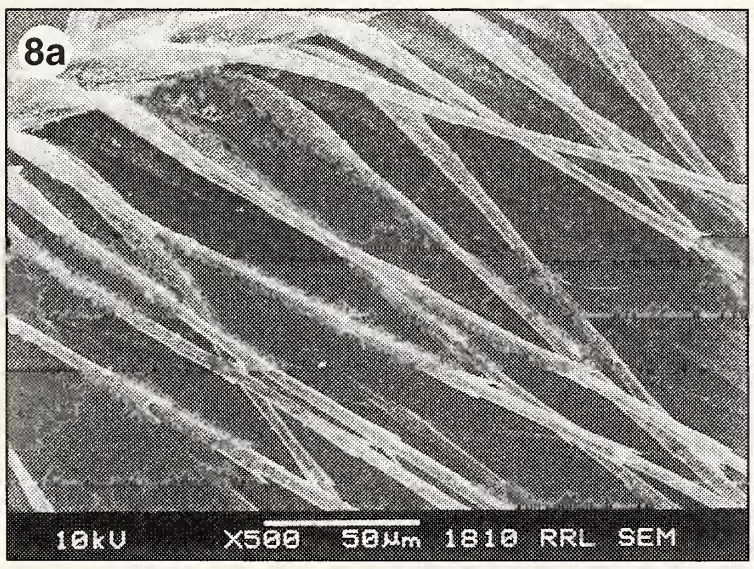
Rajaram, A.: Barbule structure PLATE 3

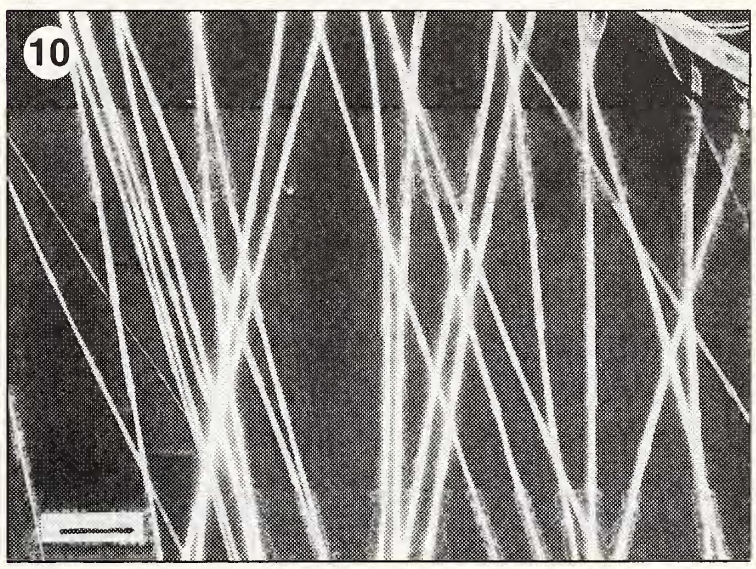






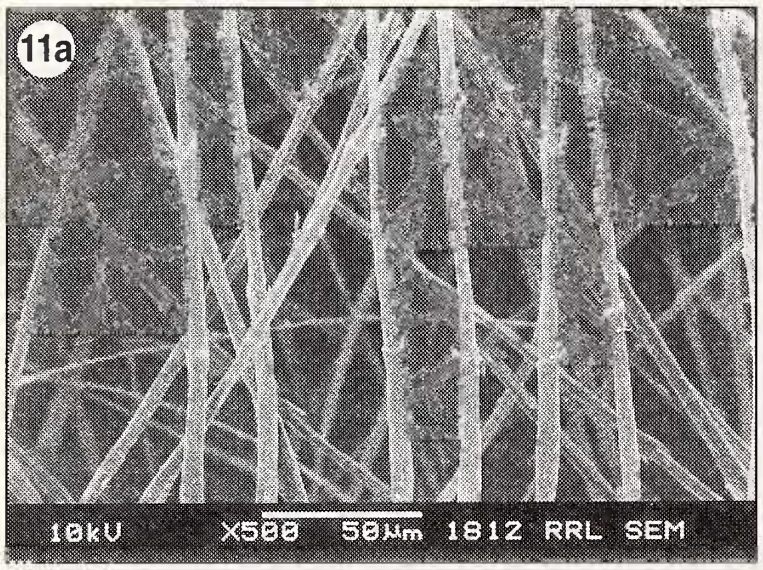


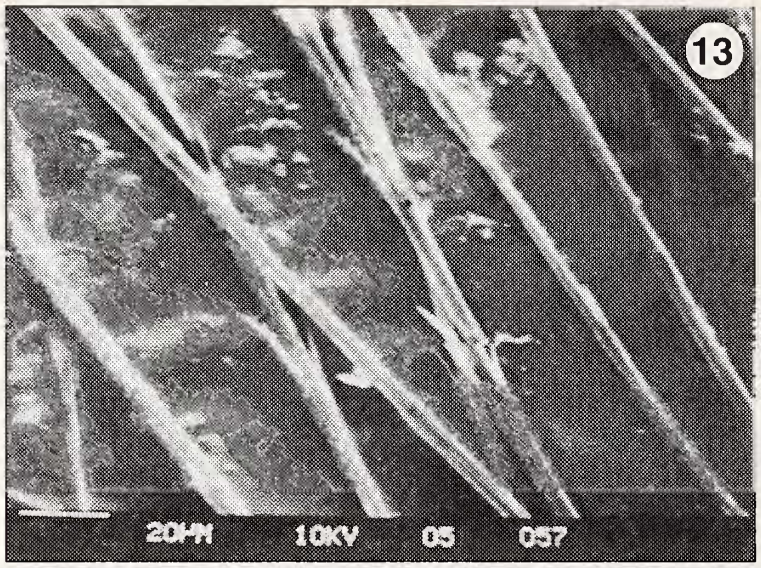


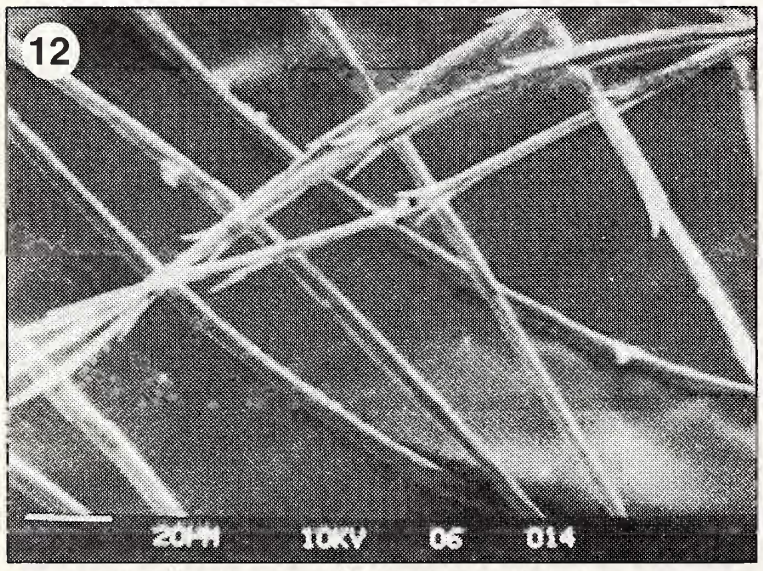


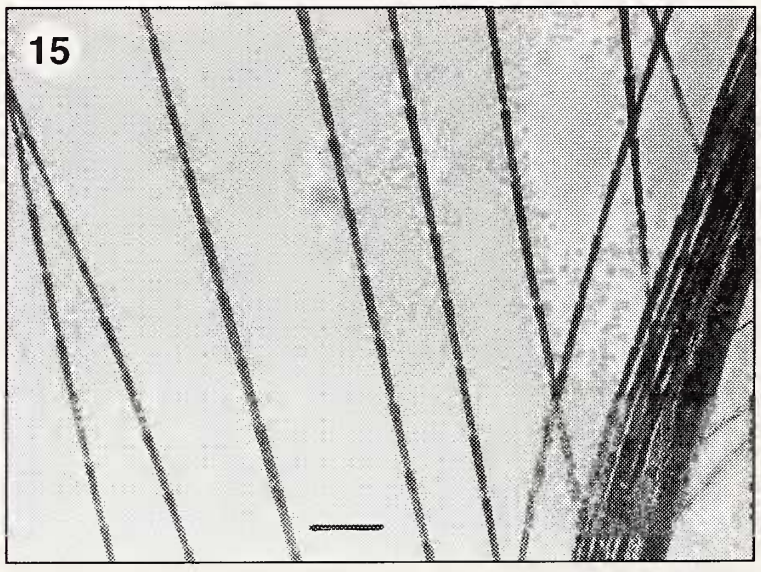
Figs 7-10: 7a. Rose-ringed parakeet (SEM), 7b. Rose-ringed parakeet (OMB), 8a. Black-crowned night-heron (SEM), 8b. Black-crowned night-heron (OMP), 9. Cattle egret (OMP), 10. Median egret (OMP)

Rajaram, A.: Barbule structure PLATE 4



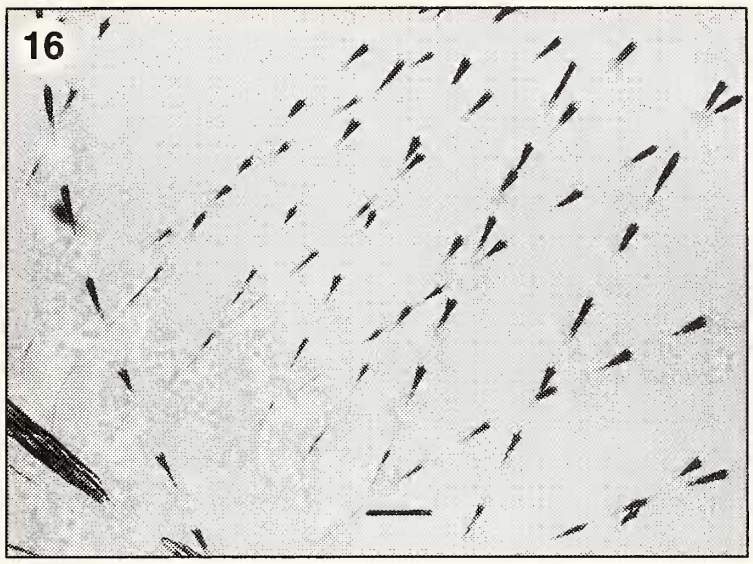


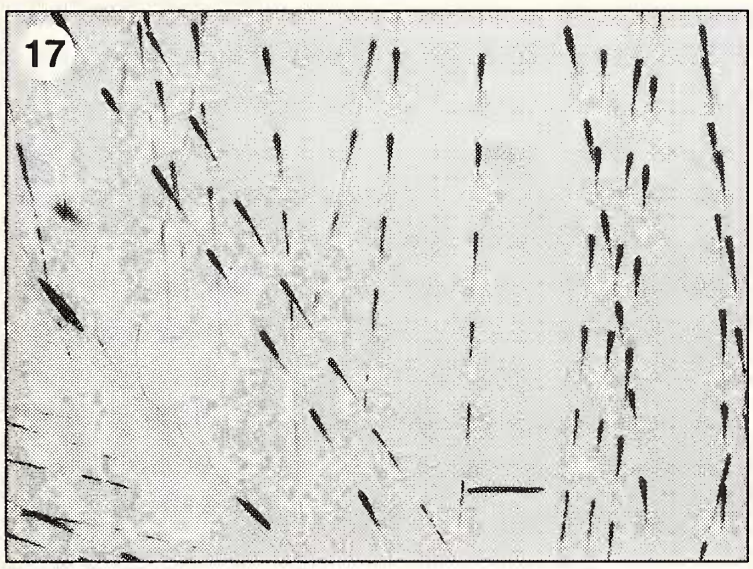


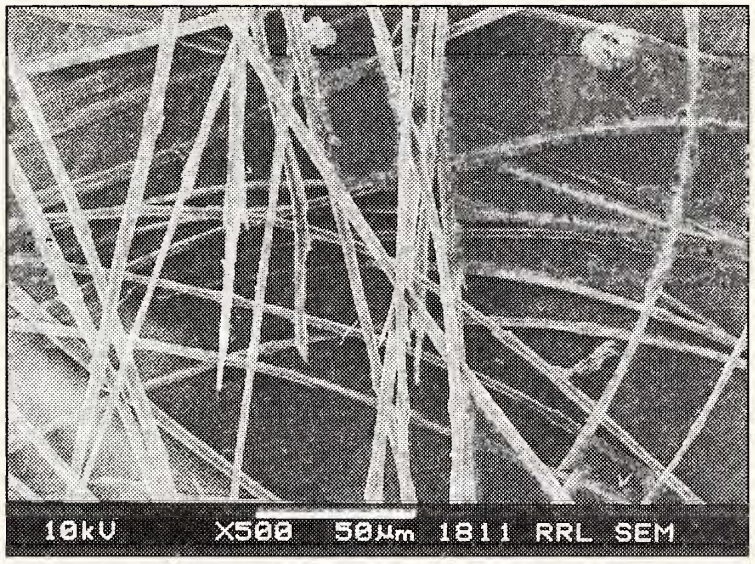


Figs 11-15: 11a. Indian white-backed vulture (SEM), 11b. Indian white-backed vulture (OMB), 12. Painted stork (SEM), 13. Spot-billed pelican (SEM), 14. Brahminy kite (OMB), 15. Greater coucal (OMB)

Rajaram, A.: Barbule structure PLATE 5







Figs 16-18: 16. Eurasian eagle owl (OMB), 17. Spotted owlet (OMB), 18. Black kite (SEM)

printed representative pictures, it could cause some confusion. Fig. 2a is from a blue rock pigeon *Columba livia*. The fresh feather has a powdery coating, which may be the powder keratin said to be found in this species. The nodal projections are clearer when this powder keratin is cleaned (Fig. 2b). Fig. 2c shows the barbule under an optical microscope. The figure is similar to the one published by Rosalind and Grubh (op. cit.), but the pigmentation is invisible in this photograph as my focus point is different. Barbules from a Pompadour green-pigeon *Treron pompadora* (Fig. 3) resemble that of the blue rock pigeon. The barbules from a house crow *Corvus splendens* (Fig. 4) show pigmentation at the nodes. There is a distinct increase in thickness from node to node towards the distal end of the barbule, as seen in the SEM. Common myna *Acridotheres tristis* feathers show distinct pigmentation above and below the node (Fig. 5b). The Indian pitta *Pitta brachyura* feather has a node with a uniform projection all around (Fig. 6a) and the pigmentation is also distinct (Fig. 6b). The roseringed parakeet *Psittacula krameri* (Fig. 7) has nodal projections extending over a longer portion as seen in the SEM, a more helpful diagnostic feature than the OMB and the figure published earlier.

In case of white feathers, there was little contrast in the OMB. Hence the samples were observed in polarized light. The black-crowned night-heron barbules (Fig. 8) can be distinguished by the shorter internodal distance compared to that of the cattle egret *Bubulcus ibis* (Fig. 9) and median egret *Mesophoyx intermedia* (Fig. 10), but there is little difference between the last two. SEM (Fig. 8a) is not useful in identifying the black-crowned night-heron or the cattle and median egrets (not shown). White feathers are thus difficult to identify if the details are not present at the nodal junctions. The SEM seen in Fig. 8a is similar to many feathers like the Indian white-backed vulture *Gyps bengalensis* (Fig. 11a), the painted stork *Mycteria leucocephala* (Fig. 12) and the spot-billed pelican *Pelecanus philippensis* (Fig. 13). However, the OMB of the Indian white-backed vulture (Fig. 11 b) is distinctive in that there seem to be pores within the barbules. Does this help in reduced buoyancy in soaring flight? The nodal projections are comparatively less prominent in birds that soar, and may be an adaptation for smoother air flow. The barbule structure of the brahminy kite *Haliastur indus* (Fig. 14), greater coucal *Centropus sinensis* (Fig. 15), Eurasian eagle owl *Bubo bubo* (Fig. 16) and spotted owlet *Athene brama* (Fig. 17) are also shown. Greater coucal barbules show pigmentation throughout. The nodal projections are more prominent in the Eurasian eagle owl than in the spotted owlet, but some relatedness is also evident. However, when we compare the barbules of the spotted owlet with the published picture of the Eurasian scops-owl *Otus scops* (Rosalind and Grubh op. cit.), there is little difference.

From the various species studied here, only two of the eight observations mentioned in the earlier paper are really helpful in identification from the barbule structure alone. In addition to: "barbules are clearly subdivided into nodes and internodes, which are often pigmented" it can be said that the nodes have a distinct projection whose shape, size and orientation are largely characteristic of the species. Often, the thickness of the barbules is related to the size of the bird, even though there are exceptions (eg. black kite *Milvus migrans* (Fig. 18) has comparatively thinner barbules). The nodal projections are more prominent in passerines than in birds that soar. The variations in barbule structure are less significant in related birds (blue rock pigeon vs. Pompadour green-pigeon, spotted owlet vs. Eurasian scops-owl). More detailed studies are required for identifying closely related species and those with mostly white plumage.

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